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THE OPEN SHED COMPARED WITH THE CLOSED BARN FOR DAIRY COWS.

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PRESENT DAIRY PRACTICE REGARDING OPEN AND CLOSED BARNS.

In order that milk and butterfat may be produced economically, it is necessary to provide shelter of some kind for dairy cattle during the cold, stormy seasons of the year. While the length of the stabling period varies in different sections of the United States, most dairy cows are now housed for at least five months, from November to March, inclusive.

An open-shed barn is usually partly or entirely closed on three sides, leaving one side, usually the south or east, open. The shed is large enough to allow each animal sufficient room for comfort and exercise, the space allowed varying from 35 to 150 square feet for each cow. The animals are allowed the freedom of the shed except at milking time. Usually there is a separate room into which the cows are driven for milking. This room may accommodate all or only a part of them. In the latter case they are milked in groups. In the milking room the cows are groomed, milked, and fed grain, after which they are driven out and another group takes their place. Roughage is fed in racks and troughs provided for that purpose in the open shed.

Monograph
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The closed barn consists of a barn entirely inclosed with stall room enough to accommodate the entire herd. The animals are kept in the barn during most of the late fall and winter, and in some dairies the entire year.

It is almost the universal practice of dairymen to keep their cows in a closed barn of some type, although in recent years some have used the open shed. Advocates of the latter have maintained that the manure is handled more easily and is better preserved and that the cows yield more milk and butterfat and are healthier, cleaner and more comfortable than when confined in a closed barn. Dairymen who have had experience in stabling cows both in closed barns and in open sheds disagree as to the merits of the two. In order to obtain definite and reliable information on the problem the experimental work hereinafter described was carried on at the Dairy Division Experiment Farm, Beltsville, Md., near Washington, D. C. The results should be applicable to other parts of the country in a similar latitude.

REVIEW OF PREVIOUS WORK.

Fraser[1] of the University of Illinois Agricultural Experiment Station, investigated the open-shed system of housing dairy cattle by sending out a list of 21 questions to dairymen in Illinois who used the open shed. The answers of the 18 dairymen who replied indicated that the milking barn was kept cleaner when the open shed was used, and that the cows and the milk were cleaner. In almost every case more bedding was required, and the cows showed no tendency to injure one another. In the latter connection it must be remembered that in the opinion of the Illinois dairymen mentioned above dehorning was believed to be necessary to the success of the open shed. All who replied to Prof. Fraser's inquiry had either dehorned or polled cattle. In answer to the question "What do you consider the chief advantage of keeping cows in this way over ordinary stabling?" no one fact was so generally emphasized as the labor-saving feature of the open shed.

In an investigation at the Maryland Agricultural Experiment Station conducted by Buckley and Lamson[2] the open stable was compared with the closed stable. The following is a brief summary of the conclusions drawn from the experiment:

> The cost of construction for the open shed is smaller than for the closed barn. The cost of labor and the cost of milk, based on quality of feed consumed, is slightly less in the open shed than in the closed barn. In the open shed, manure is better preserved and cows are kept cleaner. The supply of fresh air and light is also better.

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[1] Fraser, W. J. "Should Dairy Cows be Confined to Stalls?" Illinois Circular 93, 1904.

[2] Buckley, S. S., and Lamson, R. W. Open Shed Versus Closed Stable for Dairy Cows. Maryland Agricultural Experiment Station, Bulletin 177.

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The effects of extremely low temperatures are practically negative in reducing the flow of milk. No bad results were experienced from cows horning or butting one another when allowed the freedom of the open shed.

Davis,[1] at the Pennsylvania Agricultural Experiment Station, conducted an experiment in which the effect of open-shed housing for dairy cows was compared with the closed stable. He concludes as follows:

> It appears that the cows kept under the open shed have keener appetites and consume more roughage than those kept in stables. Sufficient protein was consumed under both systems to meet the requirements of milk and maintenance. The milk yield of the outside group decreased more rapidly each winter than that of the inside group. Sudden drops in atmospheric temperature caused decreases in milk yield for both groups, the outside group having slightly greater decrease. More bedding was required outside, but less labor was necessary to keep the cows clean. Both groups finished each winter trial in good health.

THE EXPERIMENTAL WORK.

The following details of three years' experiments carried on at the Dairy Division Experiment Farm at Beltsville, Md., show the conditions under which the work was done.

DESCRIPTION OF THE OPEN SHED.

The shed used was of frame construction, 58 feet in length and 35 feet in width, inside measurements. On the north end a space of 18 feet was partitioned off and inclosed for a milking room with stalls for 8 cows. It had a concrete platform, gutter, and alleyway. The cows were allowed the freedom of the shed except at milking time. The north end of the shed and the east and west sides up to within 18 inches of the plate were kept closed, while the south end, except for a fence to keep the cows inside when desired, was entirely open. On the south was a small dry paddock where the cows were permitted to exercise. The space available for the cows within the open shed, excluding the space of the feeding troughs, was a little more than 1,200 square feet, which allowed each of the 16 cows housed in the shed approximately 75 square feet of floor space. Two doors opened into the milking room from the shed, one through which the cows were driven in to be milked and the other through which they were driven out after milking.

This was the type of shed used during the first year of the experiment. For the last two years a new shed, entirely open on the south side, replaced the old one. The north side and both ends had large doors which swung from the top. In summer the doors were raised to permit a better circulation of air, but in the winter months, while the experiment was in progress, the doors were lowered. For the purpose of the experiment there was no difference in the two structures. The new shed was built only a short distance from the main milking barn, so it was convenient to drive the cows from the open shed into the main barn to be milked; consequently both groups of cows were milked in the same structure during the last two years of the experiment.

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[1] Davis, H. P. The Effect of Open-Shed Housing as Compared with Closed Stable for Milch Cows." Separate No. 14 (pp. 183-226), Annual Report, 1913-14, Pennsylvania State College. 1916.

THE CLOSED BARN.

The closed barn was of concrete construction, 36 feet by 59½ feet, with stall room for 26 cows, and was equipped with concrete floors, mangers, and gutters. The cows faced the outside walls, and the alleyway behind them was 8 feet wide. The feed alleys in front of the cows were 4 feet wide, and there was a 5-foot alleyway at each end of the barn. The 17 windows, 7 on each side, 1 on the north end, and 2 on the south end, provided 176 square feet of lighting space. A modification of the King system of ventilation was used.

The concrete floors on one side of the barn were covered with various kinds of insulators, such as cork brick, creosoted blocks, and planks. One-half of the cows used in the experiment stood on the floors and the other half on the concrete.

THE COWS.

The herd throughout the entire investigation consisted of 1 pure-bred Guernsey, 2 pure-bred Holsteins, 10 grade Jerseys, and 8 cows of miscellaneous breeding. The records of all the animals stabled under the two systems could not be used, on account of the irregularity of calving, etc.

PRODUCTION RECORDS.

The herd was divided into two groups. During the first year one group was kept in the open shed and the other in the closed barn. The second year the groups were reversed. The third year the groups were again reversed, which gave three years' records for comparison. Owing to the irregularity in calving, all the cows have not three years' records which are comparable. Four cows had two years' records in the open shed, an average of which was taken and compared with their one year in the closed barn. Seven cows had two years' records in the closed barn, an average of which was compared with their one year's record in the open shed.

Since the results of the housing are determined quite largely, if not entirely, upon the stabling period—November to March, inclusive—only the records obtained for the five months were studied. These records do not in any case cover the entire period of five months, owing to the irregularity of some of the cows in calving, though all records come within the five months mentioned. Only comparable records have been included. By way of illustration: Cow 201 calved October 26, 1914, while in the open shed. In 1915 she calved September 26, while in the closed barn. Therefore, in order that there should be no difference in the records due to time of freshening, records for December, 1914, and January, February, and March, 1915, in the open shed, were compared with the records for November and December, 1915, and January and February, 1916, in the closed barn. In a similar way other production records covering the same length of time in the two barns and taken the same time after calving have been compared.

The weight of each milking was recorded, and composite samples for two days were taken in the middle of the month and tested for butterfat. The butterfat test of the composite samples taken during the two days was used to calculate the total butterfat production for the month.

FEED RECORDS.

The grain mixture used throughout the experiment was the same for both groups of cows, and usually consisted of 2 parts corn meal, 2 parts wheat bran, and 1 part cottonseed meal. In some instances the mixture was varied slightly in the case of individual cows. The roughage consisted of silage and of such hay as was available on the farm—cowpea, crimson clover, and red clover.

All grain fed was accurately weighed out for each animal, and records were kept during the periods covered by the production record. The hay, silage, and other roughage fed to the cows in the open shed the first year were weighed out in quantities sufficient for the entire lot, and it was assumed that equal quantities were consumed by the various individuals. During the last two years of the experiment the roughage was weighed out to each animal. The quantity of grain fed was determined largely by the production of the individual cow, but consideration was given also to her physical condition. It was desired to keep all cows in good condition and to maintain each individual at a uniform weight. They were fed all the silage and hay they would consume without waste.

The cows in the open shed were bedded often enough to keep the inclosure clean, which was almost every day. In the closed barn the cows were bedded daily, and bedding enough was used to make them comfortable and to absorb the liquid manure. For the five months of the year during which data were taken wheat straw was used with both groups.

DISCUSSION OF RESULTS.

The milk and butterfat production records made under both the open-shed and closed-barn conditions are shown in Table 1

TABLE 1.—*Milk and butterfat records.*

Cow No.	Open shed.				Closed barn.			
	Date calved.	Milking period.	Milk.	Butterfat.	Date calved.	Milking period.	Milk.	Butterfat.
			Pounds.	*Pounds.*			*Pounds.*	*Pounds.*
1	Aug. 4, 1913 July 8, 1915	January, February, March, 1914 January, February, March, 1916	808.4	34.23	Aug. 19, 1914	January, February, March, 1915	745.5	34.12
2	Aug. 9, 1913	January, February, March, 1914	2,187.0	104.89	July 8, 1914	December, 1914, January, February, 1915	1,855.7	98.07
4	Dec. 6, 1913	do	2,239.3	99.39	Dec. 1, 1914	January, February, March, 1915	1,994.2	89.33
7	Oct. 28, 1913	do	2,368.8	93.99	Oct. 2, 1914	do	2,029.5	86.67
8	Jan. 10, 1914	February, March, 1914	1,551.5	65.16	Dec. 2, 1914	January, February, 1915	1,386.6	59.62
9	Nov. 2, 1913	January, February, March, 1914	2,026.1	87.88	Nov. 25, 1914	January, February, March, 1915	1,568.5	66.49
12	Sept. 18, 1913	February, March, 1914	650.1	26.67	Aug. 25, 1914	January, February, 1915	999.4	42.88
14	Nov. 7, 1913 Sept. 16, 1915	January, February, 1914 November, December, 1915	1,121.0	51.37	Oct. 21, 1914	do	1,338.3	67.72
17	Sept. 3, 1914	January, February, March, 1915	1,668.3	85.57	Aug. 21, 1913 Aug. 28, 1915	January, February, March, 1914 January, February, March, 1916	1,444.2	78.42
18	Sept. 6, 1913 Aug. 5, 1915	January, February, March, 1914 December, 1915, January, February, 1916	1,341.5	72.89	Sept. 18, 1914	January, February, March, 1915	1,369.2	76.44
19	Sept. 29, 1913	February, March, 1914	1,185.7	63.42	Sept. 3, 1914	January, February, 1915	1,004.3	51.60
20	Oct. 24, 1913 Oct. 17, 1915	January, February, March, 1914 January, February, March, 1916	1,135.4	49.47	Oct. 1, 1914	January, February, March, 1915	1,504.0	66.46
21	Sept. 18, 1914	December, 1914, January, February, 1915	2,717.2	141.60	Oct. 5, 1913 Aug. 7, 1915	January, February, March, 1914 November, December, 1915, January, 1916	1,596.0	90.81
22	Sept. 19, 1913	January, February, March, 1914	969.6	49.07	Oct. 4, 1914	January, February, March, 1915	1,368.8	69.92
23	Sept. 16, 1914	December, 1914, January, February, 1915	1,884.3	78.63	Oct. 5, 1913 Aug. 7, 1915	January, February, March, 1914 November, December, 1915, January, 1916	1,722.4	73.22
24	Oct. 14, 1914	February, March, 1915	1,469.7	64.68	Aug. 30, 1913	January, February, 1914	1,394.5	58.02
26	Sept. 12, 1914	January, February, 1915	878.3	53.71	Sept. 17, 1913 Oct. 27, 1915	do February, March, 1916	649.2	40.79
27	Oct. 22, 1914	February, March, 1915	1,417.2	58.91	Sept. 13, 1913 Oct. 13, 1915	January, February, 1914 February, March, 1916	1,204.6	50.53
100	Nov. 7, 1914	January, February, March, 1915	974.8	40.79	Oct. 21, 1913 Oct. 6, 1915	January, February, March, 1914 December, 1915, January, February, 1916	1,417.9	67.47
201	Oct. 26, 1914	December, 1914, January, February, March, 1915	3,797.0	132.57	Sept. 26, 1915	November, December, 1915, January, February, 1916.	3,697.9	116.09
202	Sept. 26, 1914	January, February, March, 1915	2,239.7	80.25	Oct. 7, 1913 Sept. 1, 1915	January, February, March, 1914 December, 1915, January, February, 1916	1,607.1	52.74
	Total production.		34,630.9	1,535.15			31,898.7	1,437.41

NOTE.—Where 2 years are combined, the average of the 2 years' production is given.

TABLE 2.—*Feed consumed.*

OPEN SHED.

Cow No.	Corn meal.	Wheat bran.	Cottonseed meal.	Red-clover hay.	Crimson-clover hay.	Cowpea hay.	Corn silage.	Miscellaneous.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
1	196	158	79	72	....	405	2,970	Corn stover, 155.
2	443	296	148	144	....	445	3,210	
4	462	308	153	144	....	445	3,210	
7	460	306	153	144	....	445	3,210	
8	299	200	99	144	....	208	2,032	
9	446	297	148	144	....	445	3,210	
12	181	121	60	144	....	208	2,032	
14	206	166	82	....	....	363	2,114	Corn stover, 81.
17	276	276	138	134	295	....	3,150	
18	342	265	132	72	....	423	3,198	Corn stover, 115.
19	295	196	99	144	....	208	1,770	
20	263	263	132	72	....	405	2,948	Corn stover, 155.
21	487	361	148	112	225	75	3,090	Fish meal, 63.
22	448	300	149	144	....	445	3,210	
23	392	280	112	112	225	75	3,045	Fish meal, 56.
24	378	126	126	236	....	....	1,870	
26	188	188	94	....	267	....	1,910	
27	354	118	118	236	....	....	1,870	
100	276	276	138	134	295	....	2,995	
201	654	654	326	144	424	96	6,050	
202	432	432	215	144	354	....	4,325	
Total	7,478	5,587	2,849	2,620	2,085	4,691	61,419	

CLOSED BARN.

Cow No.	Corn meal.	Wheat bran.	Cottonseed meal.	Red-clover hay.	Crimson-clover hay.	Cowpea hay.	Corn silage.	Miscellaneous.
1	164	164	82	134	295	....	2,700	
2	360	360	180	....	337	75	3,010	
4	362	362	232	15	287	....	2,805	Cottonseed hulls, 138.
7	297	297	190	15	267	....	2,805	Cottonseed hulls, 138. Bone meal, 31.
8	206	206	103	....	236	....	1,770	
9	276	276	138	124	276	....	2,540	
12	213	213	106	....	267	....	1,770	
14	236	236	118	....	236	....	1,770	
17	343	267	145	72	[1] 212	259	2,013	Cottonseed hulls, 45. Stover, 115. Bone meal, 9.
18	264	264	132	134	292	....	1,715	Dried-beet pulp, 410.
19	214	214	107	....	295	....	2,065	
20	252	252	126	124	267	....	3,150	
21	276	223	171	73	....	197	3,108	Cottonseed hulls, 276. Bone meal, 26.
22	263	263	132	124	292	....	1,470	Beet pulp, 410.
23	317	262	205	26	[2] 57	417	1,455	Cottonseed hulls, 276. Bone meal, 15. Turnips, 2,655.
24	265	177	88	....	....	712	....	Turnips, 2,700.
26	174	137	69	....	[1] 228	192	885	Stover, 102.
27	204	163	82	....	....	478	900	Turnips, 1,325. Stover, 115.
100	358	297	149	73	182	240	2,917	
201	533	533	267	....	[1] 361	349	2,475	Stover, 474.
202	319	253	128	50	....	432	3,708	Stover, 115.
Total	5,896	5,419	2,950	964	3,520	3,351	45,031	

[1] Alfalfa hay.

[2] Timothy hay.

In the data of Table 1 it will be noted that of the 21 cows kept under the two systems 15 produced more milk and butterfat when kept in the open shed, while 6 showed a higher production when kept in the closed barn. The total production while in the open shed was 34,630.9 pounds of milk, containing 1,535.15 pounds of butterfat, and that in the closed barn was 31,898.7 pounds of milk, containing 1,437.41 pounds of butterfat. Accordingly, under the open-shed system there was a total increase for the period considered, about 2.71 months, of 2,732.2 pounds of milk and 97.74 pounds of butterfat, or an average for each cow of 130.1 pounds of milk and 4.6 pounds of butterfat. The total number of months compared under each system was 57. Calculations from these figures indicate that there was an average monthly increase of 48 pounds of milk and 1.7 pounds of butterfat for each cow while stabled in the open shed.

Tables 2 and 3 show, respectively, the feed and digestible nutrients in the feed consumed by the two groups covering the same period of time as the production shown in Table 1. Where the figures in Table 1 are an average of two years the feeds in Tables 2 and 3 are also an average of two years.

TABLE 3.—*Digestible nutrients in feed consumed.*

Feeds.	Open-shed group.			Closed-barn group.		
	Protein.	Carbohydrates.	Fat.	Protein.	Carbohydrates.	Fat.
Concentrates:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Corn meal	515.98	5,159.82	261.73	406.82	4,068.24	206.36
Wheat bran	698.37	2,324.19	167.61	677.37	2,254.30	162.57
Cottonseed meal	951.57	692.31	225.07	985.30	716.85	233.05
Fish meal	44.98		13.80			
Dried-beet pulp				37.72	534.64	6.56
Total	2,210.90	8,176.32	668.21	2,107.21	7,574.03	608.54
Roughage:						
Alfalfa hay				84.91	312.39	7.21
Cowpea hay	614.52	1,580.87	46.91	438.98	1,129.29	33.51
Crimson-clover hay	202.24	767.28	20.85	345.61	1,295.36	35.20
Red-clover hay	199.12	1,029.66	47.16	73.26	378.85	17.35
Timothy hay				1.71	24.40	.68
Corn stover	10.63	214.54	3.54	19.34	390.50	6.45
Cottonseed hulls				2.62	290.71	13.09
Total	1,026.51	3,592.35	118.46	966.43	3,821.50	113.49
Silage and roots:						
Corn silage	675.61	9,212.85	429.93	495.34	6,754.65	315.22
Turnips				6.68	400.80	13.36
Total	675.61	9,212.85	429.93	502.02	7,155.45	328.58
Grand total	3,913.02	20,981.52	1,216.60	3,575.66	18,550.98	1,050.61
Pounds digestible nutrients required to produce 1 pound of fat	2.55	13.67	.79	2.49	12.91	.73

It may be noted in Table 3 that when the cows were kept in the open shed they required more digestible nutrients. However, the quantities of digestible nutrients required to produce one pound of fat in each of the two stables did not vary appreciably.

TABLE 4.—*Analyses used in calculating digestible nutrients.*[1]

Feed.	Crude protein (per 100 pounds).	Carbohydrates (per 100 pounds).	Fat (per 100 pounds).	Feed.	Crude protein (per 100 pounds).	Carbohydrates (per 100 pounds).	Fat (per 100 pounds).
Corn meal	6.9	69.0	3.5	Crimson clover	9.7	36.8	1.0
Wheat bran (all analyses)	12.5	41.6	3.0	Red clover (all analyses)	7.6	39.3	1.8
Cottonseed meal (prime)	33.4	24.3	7.9	Corn stover (medium in water)	2.1	42.4	.7
Beet pulp (dried)	4.6	65.2	.8	Cottonseed hulls	.3	33.3	1.5
Fish meal (high in fat)	37.8	....	11.6	Corn silage (well matured)	1.1	15.0	.7
Alfalfa (all analyses)	10.6	39.0	.9	Turnips	1.0	6.0	.2
Cowpea (all analyses)	13.1	33.7	1.0				

[1] From "Feeds and Feeding," by Henry and Morrison.

TABLE 5.—*Feed cost of milk and butterfat.*

Cow No.	Open-shed group.					Closed-barn group.				
	Cost of grain.	Cost of roughage.	Total cost of feed.	Feed cost of 100 pounds milk.	Feed cost of 1 pound butterfat.	Cost of grain.	Cost of roughage.	Total cost of feed.	Feed cost of 100 pounds milk.	Feed cost of 1 pound butterfat.
1	$6.58	$13.42	$20.00	$2.47	$0.58	$6.19	$11.67	$17.86	$2.40	$0.52
2	13.60	14.49	28.09	1.28	.27	13.59	12.33	25.92	1.39	.26
4	14.14	14.49	28.63	1.28	.29	14.51	11.39	25.90	1.30	.29
7	14.09	14.49	28.58	1.21	.30	11.89	11.23	23.12	1.14	.27
8	9.16	9.06	18.22	1.17	.28	7.78	7.20	14.98	1.08	.25
9	13.66	14.49	28.15	1.39	.32	10.42	10.88	21.30	1.36	.32
12	5.55	9.06	14.61	2.25	.55	8.03	7.45	15.48	1.55	.36
14	6.91	9.56	16.47	1.47	.32	8.91	7.20	16.11	1.20	.24
17	10.42	13.02	23.44	1.41	.27	11.52	11.94	23.46	1.62	.30
18	11.26	14.08	25.34	1.89	.35	16.12	8.69	24.81	1.81	.32
19	9.05	8.27	17.32	1.46	.27	8.08	8.55	16.63	1.66	.32
20	9.94	13.35	23.29	2.05	.47	9.52	12.71	22.23	1.48	.33
21	16.27	12.68	28.95	1.07	.20	10.27	12.66	22.93	1.44	.25
22	13.75	14.49	28.24	2.91	.58	16.09	7.87	23.96	1.75	.34
23	12.94	12.54	25.48	1.35	.32	12.02	17.56	29.58	1.72	.40
24	9.96	7.73	17.69	1.20	.27	8.12	13.80	21.92	1.57	.38
26	7.09	7.87	14.96	1.70	.28	5.79	7.34	13.13	2.02	.32
27	9.32	7.73	17.05	1.20	.29	6.84	10.95	17.79	1.48	.35
100	10.42	12.55	22.97	2.36	.56	12.23	12.79	25.02	1.76	.37
201	24.67	23.61	48.28	1.27	.36	20.13	16.44	36.57	.99	.32
202	16.30	17.10	33.40	1.49	.42	10.66	15.49	26.15	1.63	.50
Total	245.08	264.08	509.16	1.47	.33	228.71	236.14	464.85	1.46	.32

By comparing the data in Table 5 it may be noted that when the cows were kept in the open shed they consumed more feed and produced slightly more milk. The slight increase in production did not, however, entirely offset the extra cost of the larger quantity of feed consumed. On the average the cows when in the closed barn produced milk at a feed cost of 1 cent less per 100 pounds than when kept in the open shed; fat likewise was produced 1 cent per pound more cheaply.

It was observed, however, that one or two cows in each group were "boss cows" when kept in the open shed, and were inclined to intimidate the weaker and less aggressive animals, especially at feeding time. Cows Nos. 14 and 20 were timid individuals, and, unlike the large majority, produced decidedly less when in the open shed than when in the closed barn. No doubt this tendency of the stronger to boss and torment the weaker cows can be remedied, to a certain degree at least, by using some sort of tie on the cows when they are feeding. All cows used in the experiment were without horns; it is not practicable to attempt to keep horned cattle in an open shed.

The elimination of cows Nos. 14 and 20 from the data in Table 5 would change the results so that the feed cost of producing 100 pounds of milk in the open barn is reduced to $1.45 while that in the closed barn is increased to $1.47. As regards the butterfat, the cost of producing 1 pound becomes the same in both cases—32.73 cents.

The following prices of feeds have been used in calculating the foregoing tables. They represent a fair average of the market prices for this section during the time the investigation was in progress.

Prices of feeds.

	Per ton.
Corn meal	$33
Wheat bran	26
Cottonseed meal	33
Fish meal	35
Alfalfa hay	24
Cowpea hay	16
Red-clover hay	18
Crimson-clover hay	16
Corn stover	8
Corn silage	6
Beet pulp	30
Turnips	6
Cottonseed hulls	8

LABOR REQUIRED.

The labor required, aside from milking and feeding, is shown in Table 6. The figures in this table were compiled from accurate time records kept for each operation.

TABLE 6.—*Labor required (aside from milking and feeding).*

Labor operations (based on a herd of 16 cows).	Average per cow per day.	
	Closed barn.	Open shed.
	Min. Sec.	*Min. Sec.*
Preparing cows for milking	3 36	6 45
Removing manure and cleaning milking barn	4 25	3 11
Bedding	1 1	1 18
Total (aside from milking and feeding)	9 2	11 14

PREPARING COWS FOR MILKING.

In the open shed preparing the cows for milking included driving them into the milking room, putting them into the stanchions, brushing them, washing udders, flanks, and bellies, milking out the first few streams of milk to lower the bacterial count, and driving the cows out again. The time of milking was not taken into consideration, as the operation consumed practically the same time under each system. In the closed barn the time required to perform the same sanitary duties described above was considerably less because the cows were already stabled and the time of driving in and out was saved.

REMOVING MANURE AND FLUSHING OUT MILKING ROOM.

The second operation shown in Table 6 in the case of the open barn consisted in removing the small quantity of manure dropped by the cows while in the milking room and washing the floors, platform, and gutter of the milking room once daily. While the manure from the open shed was not removed daily, an allowance of time required to remove it has been included under this operation. It was assumed that the same quantity of manure was produced daily by the cows in the open shed as by the same number of cows in the closed barn. The time required to remove the manure from the open shed has been added to the time required to clean and flush out the milking room.

The operation in the closed barn included the time required to load the manure on a wagon and to remove it from the barn; also the time to wash up the floors, platforms, and gutters and to put the barn in the same sanitary condition as the milking room in the open shed.

With reference to the time required to keep both milking rooms clean, it may be noted (Table 6) that considerably less was needed for the small barn used in connection with the open-shed group. Doubtless the saving of time would have been even more marked had more cows been used. The figures were compiled for a herd of 16, handled in two shifts of 8 cows each. With a very little extra time for cleaning out, a much larger herd could have been milked in the small barn. It should be noted also that the figures are based on the assumption that the manure from the closed barn is to be hauled directly to the field. If it is necessary either on account of the small quantity or because of bad weather or soft fields to store the manure and haul it out later, about 1½ minutes should be added to the figures for the closed-barn cows, which would make the labor required, aside from milking and feeding, 10 minutes and 32 seconds, as against 11 minutes and 14 seconds for the open-shed cows.

BEDDING—TIME REQUIRED, POUNDS NEEDED, ETC.

By referring to Table 6 it may be noted that the time required to bed the cows did not vary widely in the two stables. A few seconds more for each cow were required in the open shed. It was observed throughout the trial, however, that the cows in the open shed kept themselves cleaner than those in the stalls.

The weights of the bedding used in each stable were recorded daily for 3 months during the trial, and the average was taken as the basis of comparison. The data thus obtained showed that the cows in the open shed required a daily average of 8.3 pounds, as compared with 4.94 pounds for the cows kept in the closed barn, or an increase of 68 per cent. Cornstalks, which at times were used for bedding the stock in the open shed, were so nearly decomposed when the manure was hauled to the field that they gave no trouble in loading on the spreader or in being evenly distributed on the land. No doubt other kinds of coarse bedding can be used with better results in open sheds than in closed barns, which is one advantage that tends to offset the extra cost of bedding in the open shed when only straw is used. On damp, rainy days more bedding was needed than in dry weather. Regardless of climatic conditions, however, the more space allowed each cow the less bedding will be required.

Good drainage is necessary for success with any open shed. Without it the quantity of bedding required is certain to be increased and the comfort of the cows seriously lessened. Water from the surrounding ground must flow away from, not toward, the shed. Eave spouts to carry the water from the roof of the shed to a place where it will readily flow away are provided for most sheds.

HEALTH AND CONTENTMENT OF THE COWS.

There seemed to be little, if any, difference in the amount of actual sickness observed under either open-shed or closed-barn conditions. In the closed barn the animals sometimes would get "big knees" from kneeling or falling on the concrete platform. This trouble was not observed when the open shed was used. Of the 21 cows used during the 3 years of the investigation two had their hips "knocked down" while in the open shed. Very probably the injuries were the result of being knocked against the side of the shed or the feed rack by stronger, more greedy, and aggressive cows.

In general, little difference could be noted in the contentment of the cows under either open-shed or closed-barn conditions. Some of the animals appeared to be more contented in the barn stalls; others appeared to be more at ease in the open shed, while still others seemed to have no preference. Under open-shed conditions the cows had more freedom. They could lie down and get up with ease, and could pick a clean place on which to lie whenever they chose. For them fresh air was abundant. Inasmuch as the closed barn used in the investigation was a modern, well-ventilated structure, no observations were needed on the subject of ventilation. In many of our poorly ventilated dairy barns, however, the impure air would doubtless be an important factor in determining the comparative merits of the two systems.

MANURE—PRESERVATION, HANDLING, ETC.

Under the open-shed system the manure was kept in an excellent state of preservation until it was hauled to the land, and it also was handled more economically. These are important considerations to the farmer who hauls manure direct from the barn to the field. Frequently the fields are too soft to be driven over and at certain seasons the growing of the crops prevents hauling the manure to the land. On this particular farm it was altogether impracticable, during most of the winter, to attempt to haul manure to the fields. Manure can be preserved until it is convenient to haul it to the fields by storing it in a manure pit. The walls and bottom of the pit are usually made of concrete and it is covered with a roof, so that it has the appearance of a small shed. When compared with the open-shed system of handling manure the manure pit has two disadvantages: First, it calls for an increased expenditure of money, and second, it necessitates handling the manure twice.

SUMMARY.

The cows consumed somewhat more feed and produced slightly more milk when kept in the open shed than when kept in the closed barn. The increase in production was not quite large enough to offset the extra feed cost.

When kept in the open shed there was a tendency for "boss cows" to deprive weaker individuals of their feed and of the normal advantages of the shed, which resulted in lower milk yields from the weaker and more timid cows.

All operations considered, milking and feeding excluded, slightly more labor was required to care for the cows when kept in the open shed.

The manure was apparently well preserved, until it could be hauled to the land, under the open-shed system. It was also handled more economically than in the closed barn. Cornstalks in the manure were sufficiently decomposed to be handled successfully with the manure spreader.

Under the open-shed system 68 per cent more bedding was required for each cow, but the cows were cleaner and more comfortable. There was little difference in the time required to bed them under the two systems. It is possible to use cornstalks or other coarse material for bedding in the open shed.

There appeared to be little if any difference in the frequency of injuries to cows under either open-shed or closed-barn conditions.

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